

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/64441 A1

(51) International Patent Classification⁷: **B41J 2/01, 2/155**

(21) International Application Number: **PCT/AU01/00217**

(22) International Filing Date: **2 March 2001 (02.03.2001)**

(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:
PQ 5957 2 March 2000 (02.03.2000) AU

(71) Applicant (for all designated States except US): **SILVERBROOK RESEARCH PTY LTD [AU/AU]; 393 Darling Street, Balmain, New South Wales 2041 (AU).**

(72) Inventor; and

(75) Inventor/Applicant (for US only): **SILVERBROOK, Kia [AU/AU]; Silverbrook Research Pty Ltd, 393 Darling Street, Balmain, New South Wales 2041 (AU).**

(74) Agent: **SILVERBROOK, Kia; Silverbrook Research Pty Ltd, 393 Darling Street, Balmain, New South Wales 2041 (AU).**

(81) Designated States (national): **AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.**

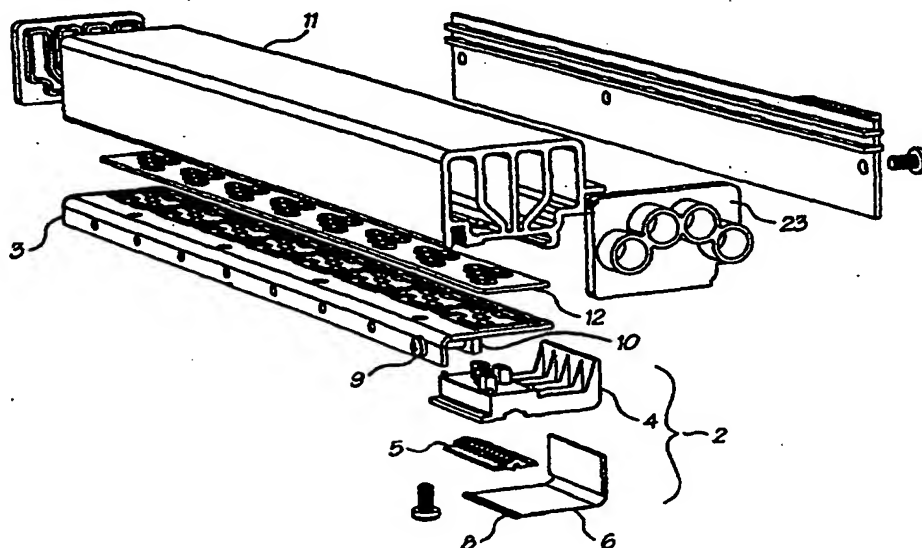
(84) Designated States (regional): **ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).**

Published:

— **with international search report**

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **MANUALLY ALIGNED PRINthead MODULES**



(57) Abstract: A modular MEMJET printhead for a digital printer wherein a plurality of printhead modules (2) may be mechanically aligned using specifically designed frame (3) supporting the modules (2). The modules (2) are sealed units with four independent ink chambers that feed the inkjet nozzles in a printhead chip (8) which is bonded to a TAB film (6). The metal frame (3) has a plurality of mounting sites (19) for mounting respective printhead modules (2) to the frame (3) wherein at least one of the mounting sites (19) having mechanical adjustment mechanism for reducing input movements to effect minute adjustments of the position of the printhead module (2) with respect to the frame (3). The adjustment mechanism uses a system of levers, pivots and a grub screw for geared reduction of the input movements to minute adjustments (less than 100 micrometers) of the printhead module relative to the frame.

BEST AVAILABLE COPY

WO 01/64441 A1

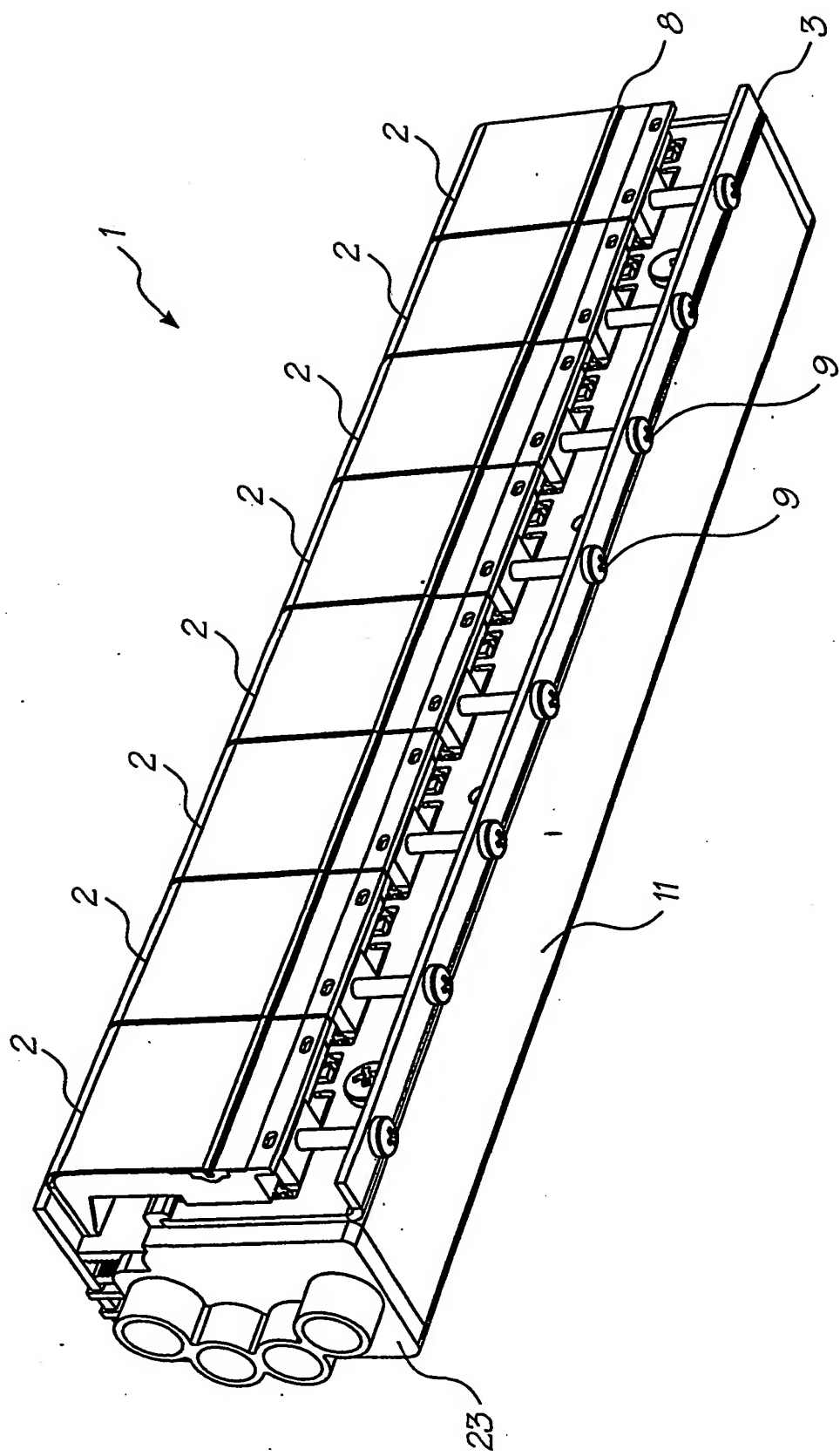


FIG. 1

2/7

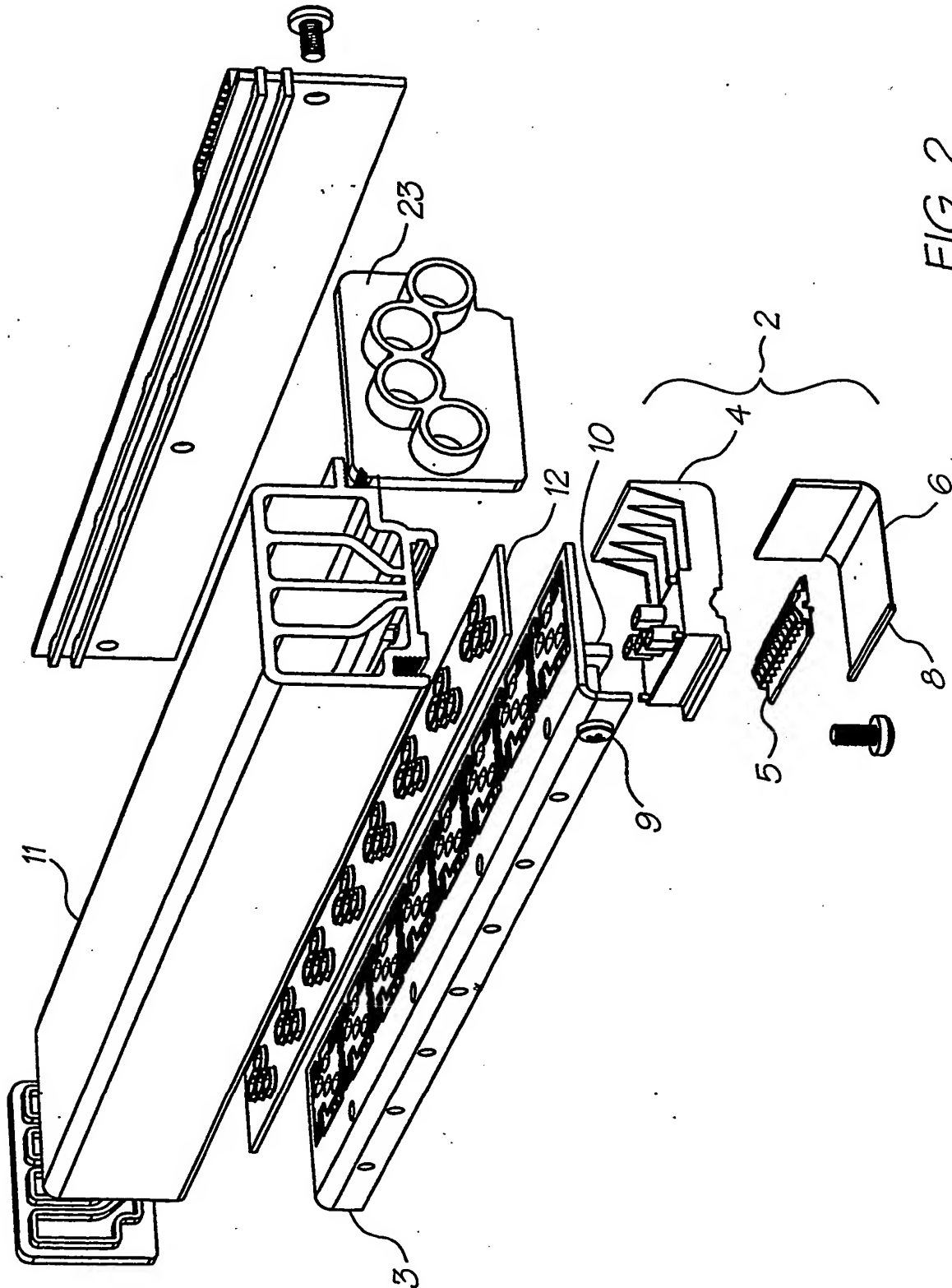


FIG. 2

3/7

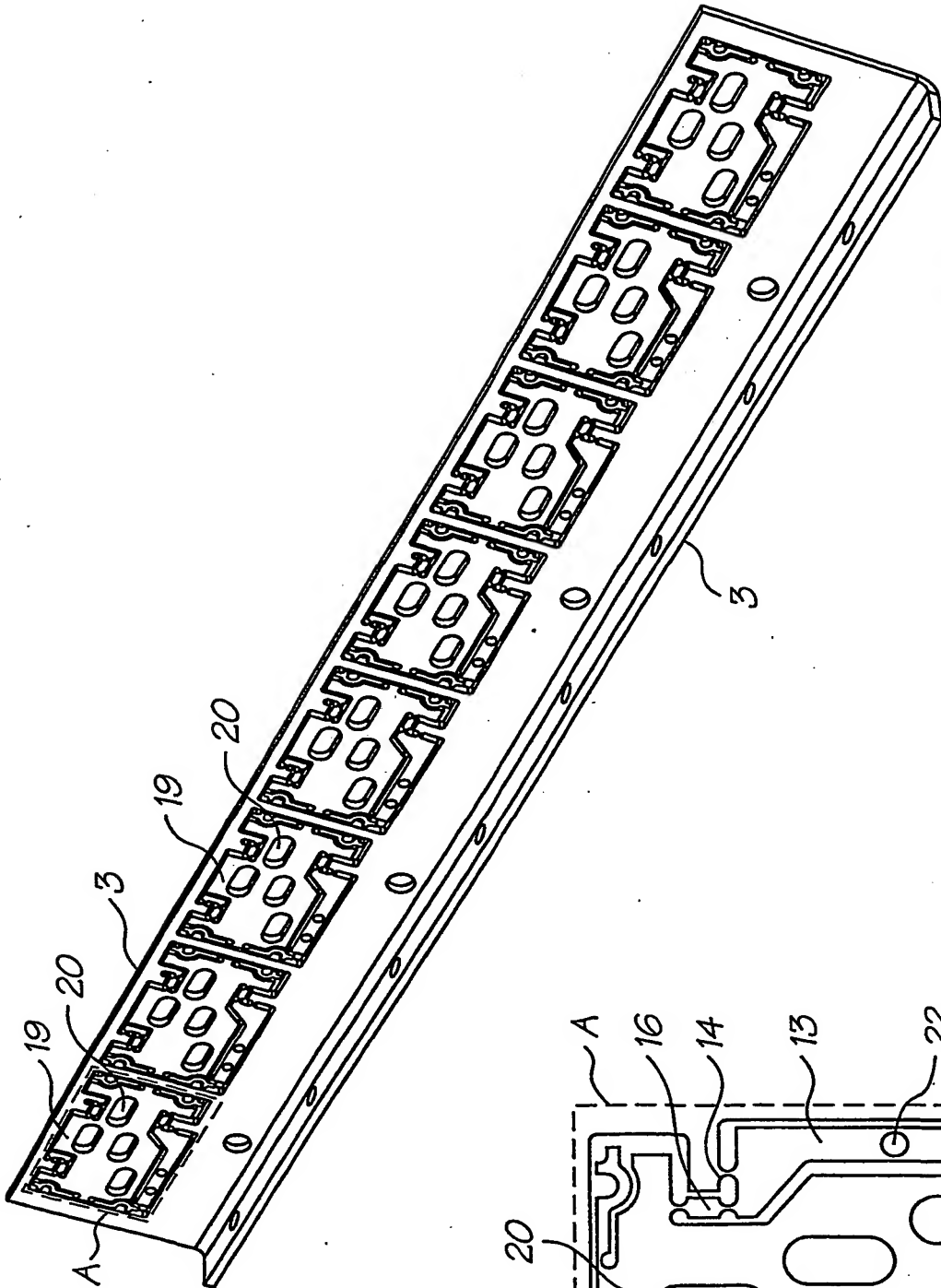


FIG. 3

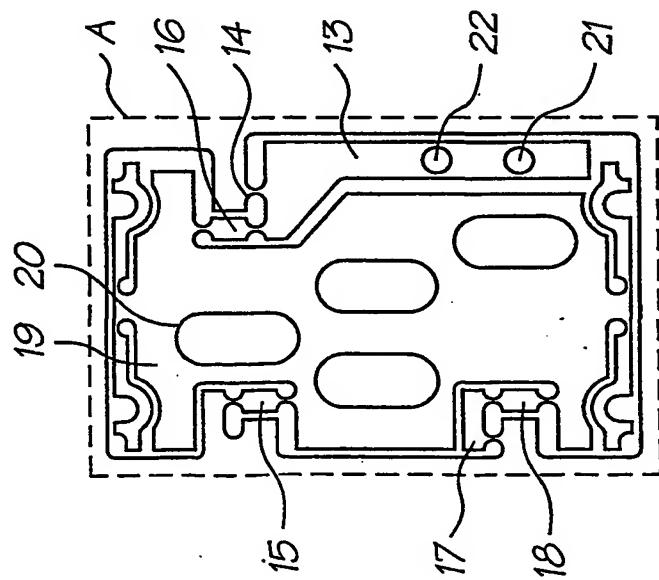


FIG. 4

4/7

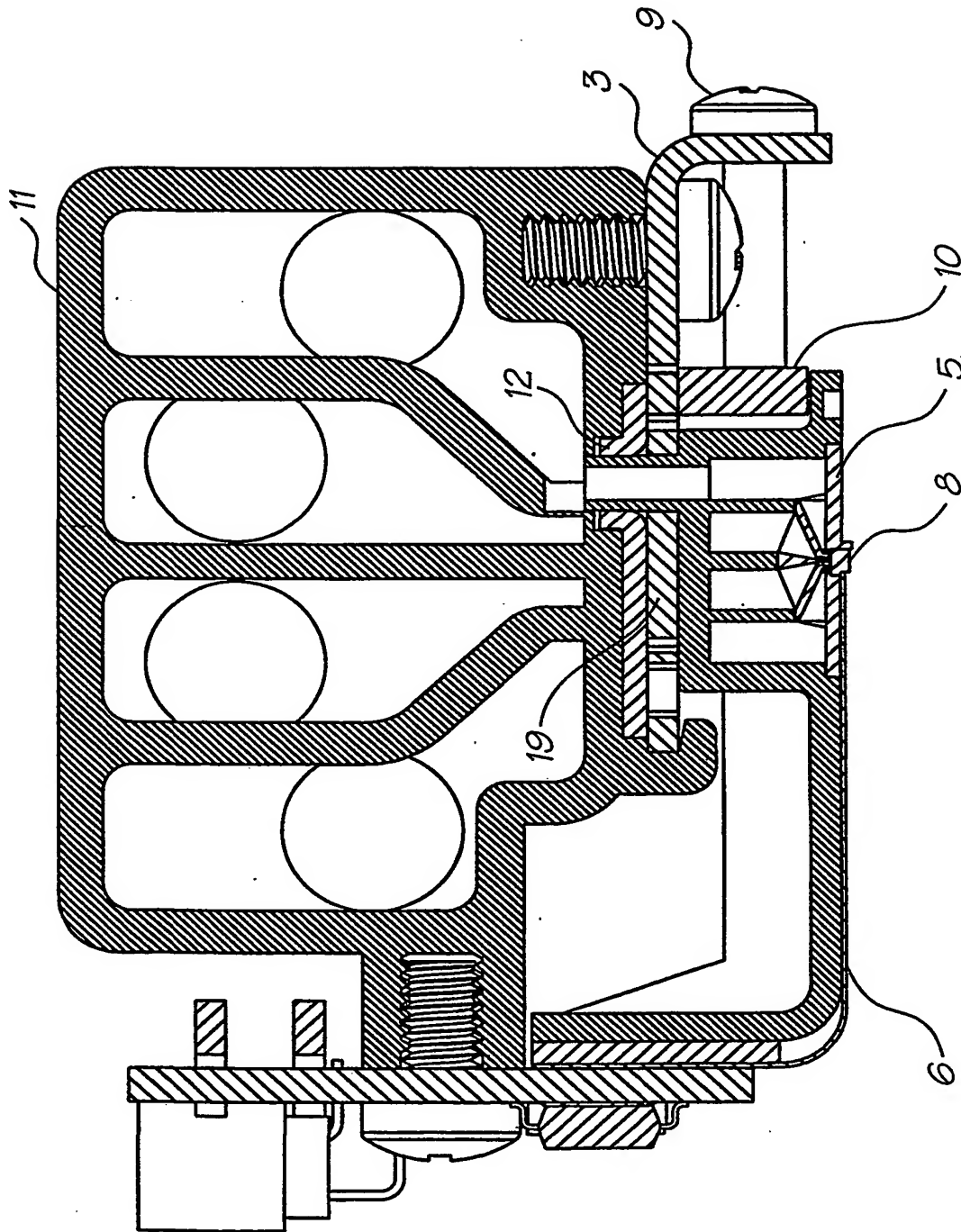


FIG. 5

5/7

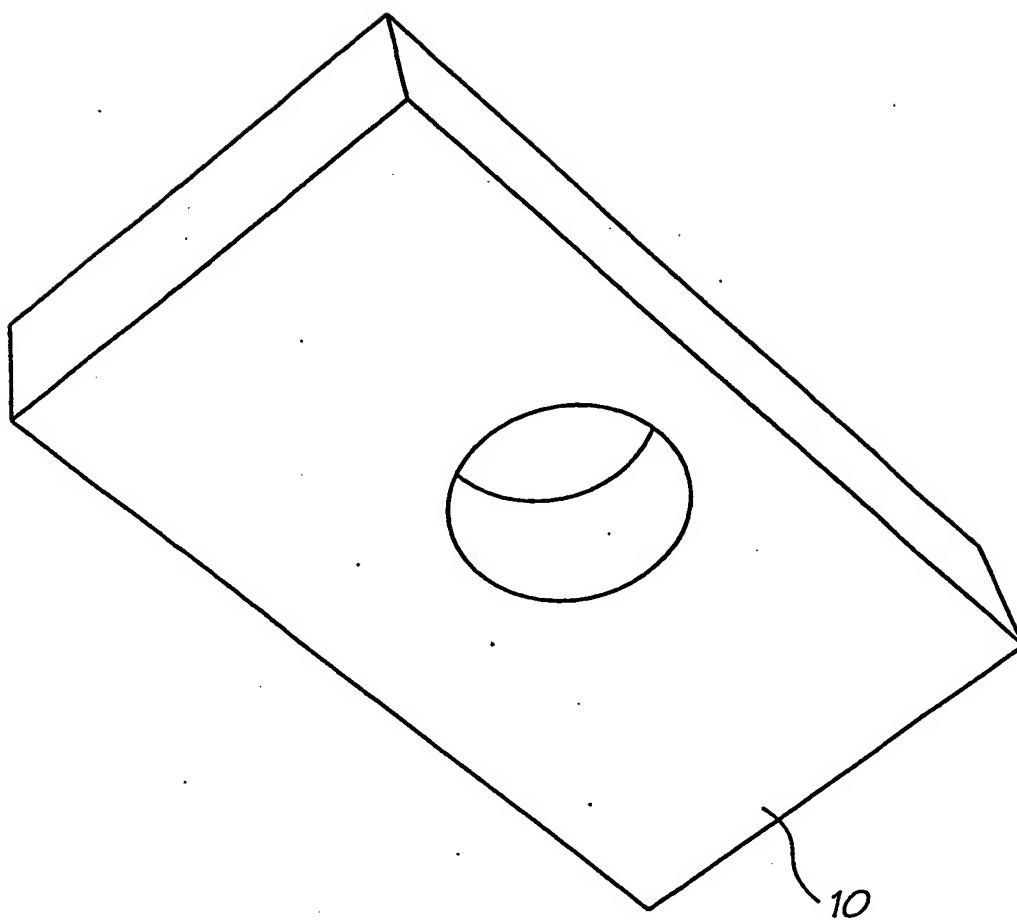


FIG. 6

6/7

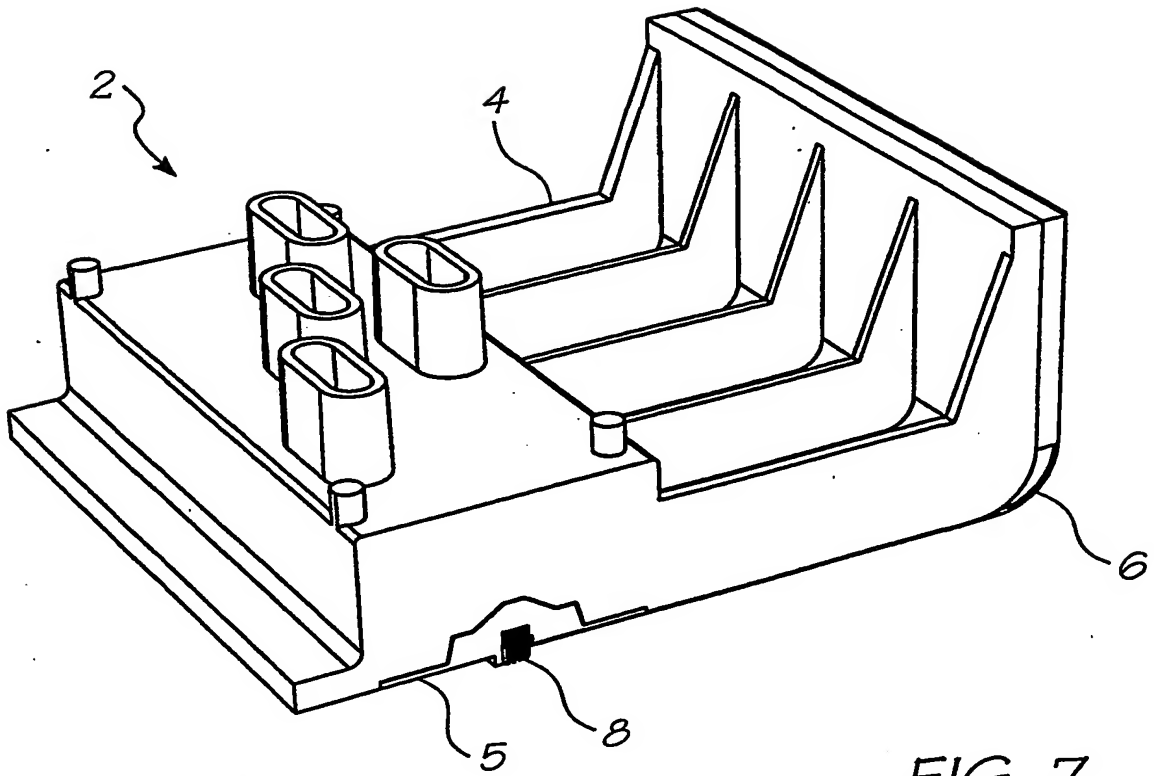


FIG. 7

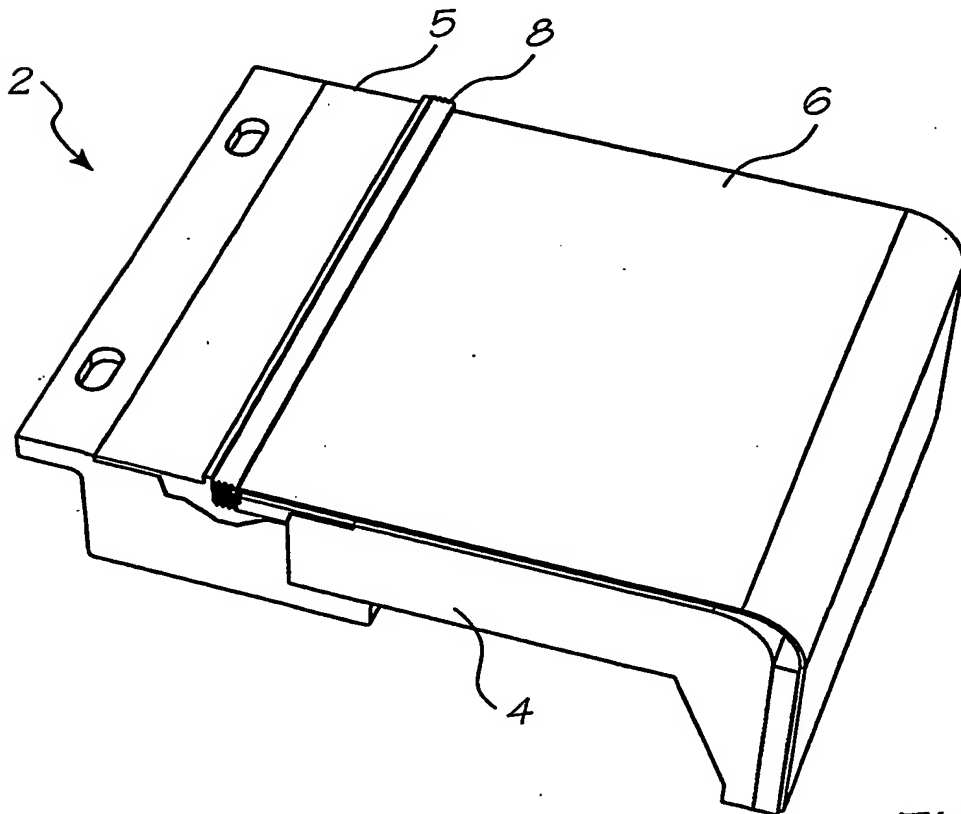


FIG. 8

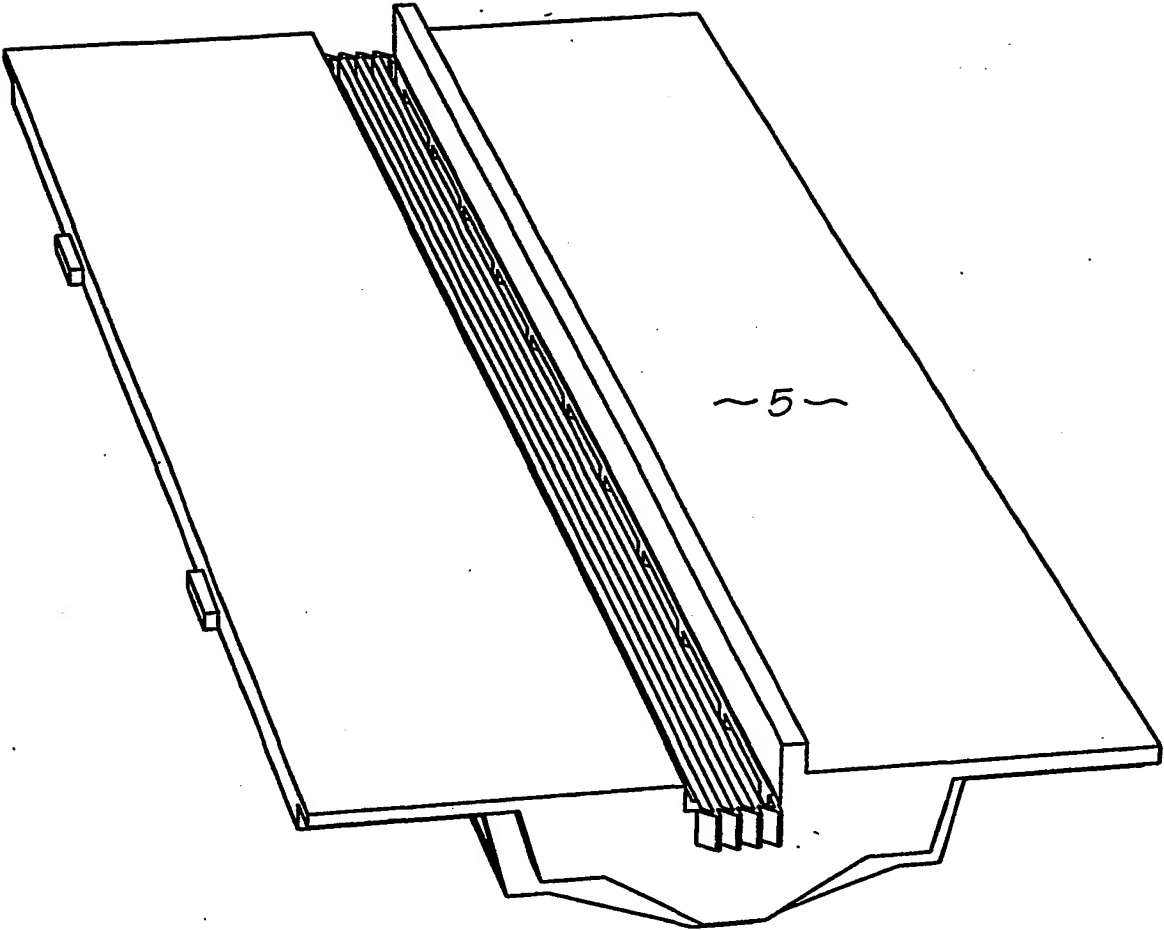


FIG. 9

- 1 -

Title.

Manually Aligned Printhead Modules

Field of the Invention.

The present invention relates to inkjet printers and in particular to pagewidth inkjet
5 printers.

Co-Pending Applications.

Various methods, systems and apparatus relating to the present invention are disclosed in the following co-pending applications filed by the applicant or assignee of the present invention on 24 May 2000:

10	PCT/AU00/00578	PCT/AU00/00579	PCT/AU00/00581	PCT/AU00/00580
	PCT/AU00/00582	PCT/AU00/00587	PCT/AU00/00588	PCT/AU00/00589
	PCT/AU00/00583	PCT/AU00/00593	PCT/AU00/00590	PCT/AU00/00591
	PCT/AU00/00592	PCT/AU00/00584	PCT/AU00/00585	PCT/AU00/00586
	PCT/AU00/00594	PCT/AU00/00595	PCT/AU00/00596	PCT/AU00/00597
15	PCT/AU00/00598	PCT/AU00/00516	PCT/AU00/00517	PCT/AU00/00511

The disclosures of these co-pending applications are incorporated herein by cross-reference. Also incorporated by cross-reference, is the disclosure of a co-filed PCT application, PCT/AU01/00216 (deriving priority from Australian Provisional Patent Application No. PQ5959).

20

Background of the Invention.

The printheads used by inkjet printers traditionally traverse back and forth within the printer as a page is fed past the printhead. To increase printing speed, pagewidth printheads have been developed so that the printhead does not need to traverse across the
25 page.

For a number of reasons, it is relatively expensive to produce pagewidth printheads in a unitary form. Therefore, to minimize costs it is preferable to produce a modular pagewidth printhead made up of a series of printhead modules.

It is necessary to align each module so that the printing from one module precisely
30 abuts the printing from the adjacent modules. For most types of printing, it is sufficient

- 2 -

to electronically align the modules. This is done by configuring the modules such that they slightly overlap with each other, and then digitally adjusting the printing from each module for a smooth transition of the print data.

Unfortunately, this requires complex manipulation of the print data allocated to the
5 respective modules. The digital controller for the printer needs to be relatively powerful to accommodate this and the associated costs can be prohibitive for the SOHO (small office/home office) market.

Summary of the Invention.

Accordingly, the present invention provides a modular printhead for a digital
10 printer, the modular printhead including:

a support frame and a plurality of printhead modules, the frame having a plurality of mounting sites for mounting respective printhead modules to the frame; wherein,

at least one of the mounting sites has an adjustment mechanism for reducing input movements to effect minute adjustments of the position of the printhead module with
15 respect to the frame.

Preferably, the adjustment mechanism uses a system of levers and pivots for geared reduction of the input movements to minute adjustments of the printhead module relative to the frame. In a further preferred form, the ratio of input movement to the resultant adjustment is at least 500 to 1.

20 In a particularly preferred form, the movement of the printhead module relative to the frame is less than 100 μ m.

In some embodiments, the adjustment mechanism includes an input lever fulcrumed against the support frame for acting on a module engagement plate, the module engagement plate being connected to the support frame by hinged link arms such
25 that the resultant movement of the plate is substantially linear. Preferably, the movement of the input lever is substantially normal to the resultant movement of the engagement plate. In a further preferred form, the input lever for each of the adjustment mechanisms is actuated by a respective grub screw threadedly engaged with the support frame.

Conveniently, the ratio of axial movement of the grub screw to the movement of the
30 plate is about 1000 to 1.

- 3 -

Conveniently, the adjustment mechanism is integrally formed with the frame wherein the fulcrum and hinged connections are formed by localized necks in the frame material.

Brief Description of the Drawings.

5 A preferred embodiment of the invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of the underside of a modular printhead according to the present invention;

Figure 2 shows an exploded perspective view of the modular printhead shown in
10 Figure 1;

Figure 3 is a perspective view of the support frame for the modular printhead shown in Figure 1;

Figure 4 is a plan view of the adjustment mechanism for one of the printhead modules shown in Figure 1;

15 Figure 5 is a cross-sectional view of the modular printhead shown in Figure 1;

Figure 6 is a perspective view of the adjuster block shown in Figure 2;

Figure 7 is a perspective view showing the top and side of a printhead module;

Figure 8 is a perspective view showing the underside of a printhead module; and

Figure 9 shows a perspective view of the micro moulding that houses the printing
20 chip in each printhead module.

Detailed Description of the Preferred Embodiments.

Referring to the figures, the modular printhead (1) includes a plurality of printhead modules (2) mounted to a metal chassis (3) which acts as a support frame. The modules (2) are sealed units with four independent ink chambers that feed the inkjet nozzles in a
25 printhead chip (8). As best seen in Figure 2, each printhead module (2) is plugged into a reservoir moulding (11) that supplies the ink through a self sealing elastomeric strip (12).

The entire modular printhead (1) may itself be a module of a larger printhead having two levels of modularity. Accordingly, the length of the overall printhead is arbitrary.

30 Referring to Figures 7 to 9, the printhead modules (2) each comprise a printhead chip (8) bonded to a TAB (tape automated bond) film (6) accommodated and supported

- 4 -

by a micro moulding (5), which is in turn adapted to mate with the cover moulding (4). The printhead chip (8) is typically a micro electro mechanical system(s) (MEMS) device.

The present invention will now be described with particular reference to the Applicant's MEMJET™ technology, various aspects of which are described in detail in the cross referenced documents. It will be appreciated that MEMJET™ is only one
5 embodiment of the invention and used here for the purposes of illustration only. It is not to be construed as restrictive or limiting in any way on the extent of the broad inventive concept.

A MEMJET™ printhead is composed of a number of identical printhead modules
10 (2) described in greater detail below. A MEMJET™ printhead is a drop-on-demand 1600 dpi inkjet printer that produces bi-level dots in up to 6 colors to produce a printed page of a particular width. Since the printhead prints dots at 1600 dpi (dots per inch), each dot is approximately 22.5µm in diameter, and the dots are spaced 15.875µm apart. Because the printing is bi-level, the input image is typically dithered or error-diffused for best
15 results.

The modules (2) are designed such that the printhead chips (8) of adjacent modules can exactly abut one another so that there are no gaps or overlap in the printing produced. To achieve this, the modules (2) must be precisely aligned with each other after being mounted on the metal chassis (1).

20 Aligning the modules (2) using digital control of the chips (8) is possible but relatively difficult and costly given the complex manipulation of the print data necessary to seamlessly join the printing from adjacent modules. The required degree of alignment can be cost effectively provided by the mechanical adjustment mechanism of the present invention.

25 Referring to Figures 3 and 4, the apertures (20) in the module engagement plate (19) receive the ink funnels for each module (2). The engagement plate (19) is integrally formed with the metal chassis (3) via hinged arms (15, 16, 17 & 18). Input lever (13) is fulcrumed against the metal chassis (3) to act on the engagement plate (19) via the hinged link arm (16). Movement of the input lever (13) is reduced by the lever arms to
30 produce a minute movement of the engagement plate (19).

By careful configuration of the input lever (13) and the hinged link arms (15, 16, 17 & 18), the resultant movement in the engagement plate (19) is substantially linear and

- 5 -

parallel to the longitudinal axis of the metal chassis (3). The skilled artisan will readily appreciate that it is convenient to configure the input lever (13) and the hinged link arms (15, 16, 17 & 18) such that input movement is substantially normal to the resultant movement for ease of access to the input lever (13). The apertures (21, 22) in each of the
5 input levers (13) are used to fit any convenient intermediate integer (not shown) selected for applying the input force to their respective input lever (13).

Referring to Figure 2, the intermediate integers chosen for the present embodiment are a series of adjuster blocks (10) individually fixed to each of the input levers. Grub screws (9) threadedly engaged with the metal chassis (3) to bear against each of the
10 adjuster block (10).

This arrangement allows precise alignment of the modules (2) by reducing the axial input motion of the grub screw (9) by ratio of about 1000 to 1 to produce minute movement of the engagement plate (19) with respect to the metal chassis (3).

The invention has been described herein by way of example only. Skilled workers
15 in this field will readily recognise many variations and modifications that do not depart from the spirit and scope of the broad inventive concept.

- 6 -

CLAIMS:-

1. A modular printhead for a digital printer, the modular printhead including:
a support frame and a plurality of printhead modules, the frame having a plurality of mounting sites for mounting respective printhead modules to the frame; wherein,
5 at least one of the mounting sites has an adjustment mechanism for reducing input movements to effect minute adjustments of the position of the printhead module with respect to the frame.
2. A modular printhead according to claim 1 wherein the adjustment mechanism uses a system of levers and pivots for geared reduction of the input movements to minute
10 adjustments of the printhead module relative to the frame.
3. A modular printhead according to claim 2 wherein the ratio of input movement to the resultant adjustment is at least 500 to 1.
4. A modular printhead according to claim 2 wherein the movement of the printhead module relative to the frame is less than 100 μ m.
- 15 5. A modular printhead according to claim 4 wherein the adjustment mechanism includes an input lever fulcrumed against the support frame for acting on a module engagement plate, the module engagement plate being connected to the support frame by hinged link arms such that the resultant movement of the plate is substantially linear.
6. A modular printhead according to claim 3 wherein the movement of the input lever
20 is substantially normal to the resultant movement of the engagement plate.
7. A modular printhead according to claim 4 wherein a respective grub screw actuates the input lever for each of the adjustment mechanisms threadedly engaged with the support frame.
8. A modular printhead according to claim 5 wherein the ratio of axial movement of
25 the grub screw to the movement of the plate is about 1000 to 1.
9. A modular printhead according to claim 5 wherein the adjustment mechanism is integrally formed in the frame wherein the fulcrum and hinged connections are formed by localized necks in the frame material.

INTERNATIONAL SEARCH REPORT

 International application No.
PCT/AU01/00217

A. CLASSIFICATION OF SUBJECT MATTER																						
Int. Cl. ⁷ : B41J 2/01, 2/155																						
According to International Patent Classification (IPC) or to both national classification and IPC																						
B. FIELDS SEARCHED																						
Minimum documentation searched (classification system followed by classification symbols)																						
IPC: B41J 2/-, 29/-																						
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																						
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)																						
DWPI: & Keywords: PRINthead, ADJUST, MINUTE, LEVER, GEAR, FRAME AND SIMILAR TERMS																						
C. DOCUMENTS CONSIDERED TO BE RELEVANT																						
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																				
X	US 5297017 A (HASELBY et al) 22 March 1994 Whole document - figures 3 and 14; column 6, line 52 to column 7, line 10	1-4, 6, 7																				
X	US 5488397 A (NGUYEN et al) 30 January 1996 Whole document - figures 10 to 14	1-4, 6, 7																				
X	US 6000782 A (LEE) 14 December 1999 Whole document - abstract; column 4, lines 15 to 50	1-4, 6, 7																				
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex																						
* Special categories of cited documents: <table border="0"> <tr> <td>"A"</td> <td>document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T"</td> <td>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"B"</td> <td>earlier application or patent but published on or after the international filing date</td> <td>"X"</td> <td>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L"</td> <td>document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y"</td> <td>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O"</td> <td>document referring to an oral disclosure, use, exhibition or other means</td> <td>"&"</td> <td>document member of the same patent family</td> </tr> <tr> <td>"P"</td> <td>document published prior to the international filing date but later than the priority date claimed</td> <td></td> <td></td> </tr> </table>			"A"	document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"B"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family	"P"	document published prior to the international filing date but later than the priority date claimed		
"A"	document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention																			
"B"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone																			
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art																			
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family																			
"P"	document published prior to the international filing date but later than the priority date claimed																					
Date of the actual completion of the international search 18 May 2001		Date of mailing of the international search report 1 June 2001																				
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929		Authorized officer <i>A.G.</i> ADRIANO GIACOBETTI Telephone No : (02) 6283 2517																				

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU01/00217

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	5297017	EP	540243	HK	1585/96	JP	5254114
US	5488397	EP	539812	JP	5220951	US	5241325
		US	5861899	EP	540987	HK	1984/96
		JP	5238072	US	5880757	EP	827839
		JP	10086415				
US	6000782	EP	830947	JP	10100400		
END OF ANNEX							

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☒ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

THIS PAGE BLANK (USPTO,